6.7.2.8.4 Every portable tank with a capacity less than 1,900 ℓ should be fitted with a pressure-relief device, which may be a frangible disc when this disc complies with the provisions of 6.7.2.11.1. When no spring-loaded pressure-relief device is used, the frangible disc should be set to rupture at a nominal pressure equal to the test pressure.

6.7.2.8.5 When the shell is fitted for pressure discharge, the inlet line should be provided with a suitable pressure-relief device set to operate at a pressure not higher than the MAWP of the shell, and a stop-valve should be fitted as close to the shell as reasonably practicable.

6.7.2.9 Setting of pressure-relief devices

6.7.2.9.1 It should be noted that the pressure-relief devices should operate only in conditions of excessive rise in temperature, since the shell should not be subject to undue fluctuations of pressure during normal conditions of transport (see 6.7.2.12.2).

6.7.2.9.2 The required pressure-relief device should be set to start to discharge at a nominal pressure of five sixths of the test pressure for shells having a test pressure of not more than 4.5 bar and 110% of two thirds of the test pressure for shells having a test pressure of more than 4.5 bar. After discharge, the device should close at a pressure not more than 10% below the pressure at which the discharge starts. The device should remain closed at all lower pressures. This requirement does not prevent the use of vacuum-relief or combination pressure-relief and vacuum-relief devices.

6.7.2.10 Fusible elements

6.7.2.10.1 Fusible elements should operate at a temperature between 110°C and 149°C on condition that the pressure in the shell at the fusing temperature will be not more than the test pressure. They should be placed at the top of the shell with their inlets in the vapour space, and in no case should they be shielded from external heat. Fusible elements should not be utilized on portable tanks with a test pressure which exceeds 2.65 bar. Fusible elements used on portable tanks intended for the transport of elevated-temperature substances should be designed to operate at a temperature higher than the maximum temperature that will be experienced during transport and should be to the satisfaction of the competent authority or its authorized body.

6.7.2.11 Frangible discs

6.7.2.11.1 Except as specified in 6.7.2.8.3, frangible discs should be set to rupture at a nominal pressure equal to the test pressure throughout the design temperature range. Particular attention should be given to the provisions of 6.7.2.5.1 and 6.7.2.8.3 if frangible discs are used.

6.7.2.11.2 Frangible discs should be appropriate for the vacuum pressures which may be produced in the portable tank.

6.7.2.12 Capacity of pressure-relief devices

6.7.2.12.1 The spring-loaded pressure-relief device required by 6.7.2.8.1 should have a minimum cross-sectional flow area equivalent to an orifice of 31.75 mm diameter. Vacuum-relief devices, when used, should have a cross-sectional flow area not less than 284 mm^2.

6.7.2.12.2 The combined delivery capacity of the relief devices in condition of complete fire engulfment of the portable tank should be sufficient to limit the pressure in the shell to 20% above the start-to-discharge pressure of the pressure-limiting device. Emergency pressure-relief devices may be used to achieve the full relief capacity prescribed. These devices may be fusible, spring-loaded or frangible disc components, or a combination of spring-loaded and frangible disc devices. The total required capacity of the relief devices may be determined using the formula in 6.7.2.12.2.1 or the table in 6.7.2.12.2.3.

6.7.2.12.2.1 To determine the total required capacity of the relief devices, which should be regarded as being the sum of the individual capacities of all the contributing devices, the following formula should be used:

$$Q = 12.4 \frac{FA^{0.82}}{LC} \sqrt{\frac{ZT}{M}}$$

where:

Q = minimum required rate of discharge in cubic metres of air per second (m^3/s) at standard conditions: 1 bar and 0°C (273 K);

F = a coefficient with the following value:
for uninsulated shells, $F = 1$
for insulated shells, $F = U(649 - t)/13.6$ but in no case is less than 0.25

where:

U = thermal conductance of the insulation, in $kW \cdot m^{-2} \cdot K^{-1}$, at 38°C;
t = actual temperature of the substance during filling (in °C) (when this temperature is unknown, let $t = 15°C$);

The value of F given above for insulated shells may be taken provided that the insulation is in conformance with 6.7.2.12.2.4;

A = total external surface area of shell in square metres;

Z = the gas compressibility factor in the accumulating condition (when this factor is unknown, let Z equal 1.0);

T = absolute temperature in kelvin (°C + 273) above the pressure-relief devices in the accumulating condition;

L = the latent heat of vaporization of the liquid, in kJ/kg, in the accumulating condition;

M = molecular mass of the discharged gas;

C = a constant which is derived from one of the following formulae as a function of the ratio k of specific heats:

$$k = \frac{C_p}{C_v}$$

where:

C_p = specific heat at constant pressure; and

C_v = specific heat at constant volume.

When $k > 1$:

$$C = \sqrt{k\left(\frac{2}{k+1}\right)^{\frac{k+1}{k-1}}}$$

When $k = 1$ or k is unknown:

$$C = \frac{1}{\sqrt{e}} = 0.607$$

where e is the mathematical constant 2.7183.

C may also be taken from the following table:

k	C	k	C	k	C
1.00	0.607	1.26	0.660	1.52	0.704
1.02	0.611	1.28	0.664	1.54	0.707
1.04	0.615	1.30	0.667	1.56	0.710
1.06	0.620	1.32	0.671	1.58	0.713
1.08	0.624	1.34	0.674	1.60	0.716
1.10	0.628	1.36	0.678	1.62	0.719
1.12	0.633	1.38	0.681	1.64	0.722
1.14	0.637	1.40	0.685	1.66	0.725
1.16	0.641	1.42	0.688	1.68	0.728
1.18	0.645	1.44	0.691	1.70	0.731
1.20	0.649	1.46	0.695	2.00	0.770
1.22	0.652	1.48	0.698	2.20	0.793
1.24	0.656	1.50	0.701		

6.7.2.1.2.2.2 As an alternative to the formula above, shells designed for the transport of liquids may have their relief devices sized in accordance with the table in 6.7.2.12.2.3. This table assumes an insulation value of $F = 1$ and should be adjusted accordingly when the shell is insulated. Other values used in determining this table are:

$M = 86.7$; $T = 394$ K; $L = 334.94$ kJ/kg; $C = 0.607$; $Z = 1$

6.7.2.12.2.3 Minimum emergency vent capacity, *Q*, in cubic metres of air per second at 1 bar and 0°C (273 K):

A Exposed area (square metres)	*Q* (cubic metres of air per second)	*A* Exposed area (square metres)	*Q* (cubic metres of air per second)
2	0.230	37.5	2.539
3	0.320	40	2.677
4	0.405	42.5	2.814
5	0.487	45	2.949
6	0.565	47.5	3.082
7	0.641	50	3.215
8	0.715	52.5	3.346
9	0.788	55	3.476
10	0.859	57.5	3.605
12	0.998	60	3.733
14	1.132	62.5	3.860
16	1.263	65	3.987
18	1.391	67.5	4.112
20	1.517	70	4.236
22.5	1.670	75	4.483
25	1.821	80	4.726
27.5	1.969	85	4.967
30	2.115	90	5.206
32.5	2.258	95	5.442
35	2.400	100	5.676

6.7.2.12.2.4 Insulation systems, used for the purpose of reducing venting capacity, should be approved by the competent authority or its authorized body. In all cases, insulation systems approved for this purpose should:

(a) remain effective at all temperatures up to 649°C; and

(b) be jacketed with a material having a melting point of 700°C or greater.

6.7.2.13 Marking of pressure-relief devices

6.7.2.13.1 Every pressure-relief device should be clearly and permanently marked with the following:

.1 the pressure (in bar or kPa) or temperature (in °C) at which it is set to discharge;

.2 the allowable tolerance at the discharge pressure for spring-loaded devices;

.3 the reference temperature corresponding to the rated pressure for frangible discs;

.4 the allowable temperature tolerance for fusible elements; and

.5 the rated flow capacity of the device in standard cubic metres of air per second (m^3/s).

When practicable, the following information should also be shown:

.6 the manufacturer's name and relevant catalogue number.

6.7.2.13.2 The rated flow capacity marked on the pressure-relief devices should be determined according to ISO 4126-1:1996.

6.7.2.14 Connections to pressure-relief devices

6.7.2.14.1 Connections to pressure-relief devices should be of sufficient size to enable the required discharge to pass unrestricted to the safety device. No stop-valve should be installed between the shell and the pressure-relief devices except where duplicate devices are provided for maintenance or other reasons and the stop-valves serving the devices actually in use are locked open or the stop-valves are interlocked so that at least one of the duplicate devices is always in use. There should be no obstruction in an opening leading to a vent or pressure-relief device which might restrict or cut off the flow from the shell to that device. Vents or pipes from the pressure-relief device outlets, when used, should deliver the relieved vapour or liquid to the atmosphere in conditions of minimum back-pressure on the relieving devices.

6.7.2.15 Siting of pressure-relief devices

6.7.2.15.1 Each pressure-relief device inlet should be situated on top of the shell in a position as near the longitudinal and transverse centre of the shell as reasonably practicable. All pressure-relief device inlets should, under maximum filling conditions, be situated in the vapour space of the shell and the devices should be so arranged as to ensure the escaping vapour is discharged unrestrictedly. For flammable substances, the escaping

vapour should be directed away from the shell in such a manner that it cannot impinge upon the shell. Protective devices which deflect the flow of vapour are permissible provided the required relief-device capacity is not reduced.

6.7.2.15.2 Arrangements should be made to prevent access to the pressure-relief devices by unauthorized persons and to protect the devices from damage caused by the portable tank overturning.

6.7.2.16 Gauging devices

6.7.2.16.1 Glass level-gauges and gauges made of other fragile material, which are in direct communication with the contents of the tank, should not be used.

6.7.2.17 Portable tank supports, frameworks, lifting and tie-down attachments

6.7.2.17.1 Portable tanks should be designed and constructed with a support structure to provide a secure base during transport. The forces specified in 6.7.2.2.12 and the safety factor specified in 6.7.2.2.13 should be considered in this aspect of the design. Skids, frameworks, cradles or other similar structures are acceptable.

6.7.2.17.2 The combined stresses caused by portable tank mountings (such as cradles, framework, etc.) and portable tank lifting and tie-down attachments should not cause excessive stress in any portion of the shell. Permanent lifting and tie-down attachments should be fitted to all portable tanks. Preferably they should be fitted to the portable tank supports but may be secured to reinforcing plates located on the shell at the points of support.

6.7.2.17.3 In the design of supports and frameworks, the effects of environmental corrosion should be taken into account.

6.7.2.17.4 Forklift pockets should be capable of being closed off. The means of closing forklift pockets should be a permanent part of the framework or permanently attached to the framework. Single-compartment portable tanks with a length less than 3.65 m need not have closed-off forklift pockets provided that:

.1 the shell, including all the fittings, is well protected from being hit by the forklift blades; and

.2 the distance between the centres of the forklift pockets is at least half of the maximum length of the portable tank.

6.7.2.17.5 When portable tanks are not protected during transport, according to 4.2.1.2, the shells and service equipment should be protected against damage to the shell and service equipment resulting from lateral or longitudinal impact or overturning. External fittings should be protected so as to preclude the release of the shell contents upon impact or overturning of the portable tank on its fittings. Examples of protection include:

.1 protection against lateral impact, which may consist of longitudinal bars protecting the shell on both sides at the level of the median line;

.2 protection of the portable tank against overturning, which may consist of reinforcement rings or bars fixed across the frame;

.3 protection against rear impact, which may consist of a bumper or frame;

.4 protection of the shell against damage from impact or overturning by use of an ISO frame in accordance with ISO 1496-3:1995.

6.7.2.18 Design approval

6.7.2.18.1 The competent authority or its authorized body should issue a design approval certificate for any new design of a portable tank. This certificate should attest that a portable tank has been surveyed by that authority, is suitable for its intended purpose and meets the provisions of this chapter and, where appropriate, the provisions for substances provided in chapter 4.2 and in the Dangerous Goods List in chapter 3.2. When a series of portable tanks are manufactured without change in the design, the certificate should be valid for the entire series. The certificate should refer to the prototype test report, the substances or group of substances allowed to be transported, the materials of construction of the shell and lining (when applicable) and an approval number. The approval number should consist of the distinguishing sign or mark of the State in whose territory the approval was granted, i.e. the distinguishing sign for use in international traffic as prescribed by the Convention on Road Traffic, Vienna, 1968, and a registration number. Any alternative arrangements according to 6.7.1.2 should be indicated on the certificate. A design approval may serve for the approval of smaller portable tanks made of materials of the same kind and thickness, by the same fabrication techniques and with identical supports, equivalent closures and other appurtenances.

6.7.2.18.2 The prototype test report for the design approval should include at least the following:

.1 the results of the applicable framework test specified in ISO 1496-3:1995;

.2 the results of the initial inspection and test in 6.7.2.19.3; and

.3 the results of the impact test in 6.7.2.19.1, when applicable.

6.7.2.19 Inspection and testing

6.7.2.19.1 For portable tanks meeting the definition of "container" in the CSC, a prototype representing each design should be subjected to an impact test. The prototype portable tank should be shown to be capable of absorbing the forces resulting from an impact not less than 4 times (4*g*) the MPGM of the fully filled portable tank at a duration typical of the mechanical shocks experienced in rail transport. The following is a listing of standards describing methods acceptable for performing the impact test:

Association of American Railroads.
Manual of Standards and Recommended Practices,
Specifications for Acceptability of Tank Containers (AAR.600), 1992

Canadian Standards Association (CSA),
Highway Tanks and Portable Tanks for the Transportation of Dangerous Goods
(B620-1987)

Deutsche Bahn AG
Zentralbereich Technik, Minden
Portable tanks, longitudinal dynamic impact test

Société Nationale des Chemins de Fer Français
C.N.E.S.T. 002-1966.
Tank containers, longitudinal external stresses and dynamic impact tests

Spoornet, South Africa
Engineering Development Centre (EDC)
Testing of ISO Tank Containers
Method EDC/TES/023/000/1991-06

6.7.2.19.2 The shell and items of equipment of each portable tank should be inspected and tested before being put into service for the first time (initial inspection and test) and thereafter at not more than five-year intervals (5-year periodic inspection and test) with an intermediate periodic inspection and test (2.5-year periodic inspection and test) midway between the 5-year periodic inspections and tests. The 2.5-year periodic inspection and test may be performed within 3 months of the specified date. An exceptional inspection and test should be performed regardless of the date of the last periodic inspection and test when necessary according to 6.7.2.19.7.

6.7.2.19.3 The initial inspection and test of a portable tank should include a check of the design characteristics, an internal and external examination of the portable tank and its fittings with due regard to the substances to be transported, and a pressure test. Before the portable tank is placed into service, a leakproofness test and a test of the satisfactory operation of all service equipment should also be performed. When the shell and its fittings have been pressure-tested separately, they should be subjected together after assembly to a leakproofness test.

6.7.2.19.4 The 5-year periodic inspection and test should include an internal and external examination and, as a general rule, a hydraulic pressure test. For tanks only used for the transport of solid substances other than toxic or corrosive substances, which do not liquefy during transport, the hydraulic pressure test may be replaced by a suitable pressure test at 1.5 times MAWP, subject to competent authority approval. Sheathing, thermal insulation and the like should be removed only to the extent required for reliable appraisal of the condition of the portable tank. When the shell and equipment have been pressure-tested separately, they should be subjected together after assembly to a leakproofness test.

6.7.2.19.4.1 The heating system should be subject to inspection and tests including pressure tests on heating coils or ducts during the 5-year periodic inspection.

6.7.2.19.5 The intermediate 2.5-year periodic inspection and test should at least include an internal and external examination of the portable tank and its fittings with due regard to the substances intended to be transported, a leakproofness test and a test of the satisfactory operation of all service equipment. Sheathing, thermal insulation and the like should be removed only to the extent required for reliable appraisal of the condition of the portable tank. For portable tanks dedicated to the transport of a single substance, the 2.5-year internal examination may be waived or substituted by other test methods or inspection procedures by the competent authority or its authorized body.

6.7.2.19.6 A portable tank may not be filled and offered for transport after the date of expiry of the last 5-year or 2.5-year periodic inspection and test as required by 6.7.2.19.2. However, a portable tank filled prior to the date of expiry of the last periodic inspection and test may be transported for a period not to exceed three months beyond the date of expiry of the last periodic test or inspection. In addition, a portable tank may be transported after the date of expiry of the last periodic test and inspection:

.1 after emptying but before cleaning, for purposes of performing the next required test or inspection prior to refilling; and

.2 unless otherwise approved by the competent authority, for a period not to exceed six months beyond the date of expiry of the last periodic test or inspection, in order to allow the return of dangerous goods for proper disposal or recycling. Reference to this exemption should be mentioned in the transport document.

6.7.2.19.7 The exceptional inspection and test is necessary when the portable tank shows evidence of damaged or corroded areas, or leakage, or other conditions that indicate a deficiency that could affect the integrity of the portable tank. The extent of the exceptional inspection and test should depend on the amount of damage or deterioration of the portable tank. It should include at least the 2.5-year periodic inspection and test according to 6.7.2.19.5.

6.7.2.19.8 The internal and external examinations should ensure that:

.1 the shell is inspected for pitting, corrosion, or abrasions, dents, distortions, defects in welds or any other conditions, including leakage, that might render the shell unsafe for transport;

.2 the piping, valves, heating/cooling system, and gaskets are inspected for corroded areas, defects, and other conditions, including leakage, that might render the portable tank unsafe for filling, discharge or transport;

.3 devices for tightening manhole covers are operative and there is no leakage at manhole covers or gaskets;

.4 missing or loose bolts or nuts on any flanged connection or blank flange are replaced or tightened;

.5 all emergency devices and valves are free from corrosion, distortion and any damage or defect that could prevent their normal operation. Remote closure devices and self-closing stop-valves should be operated to demonstrate proper operation;

.6 linings, if any, are inspected in accordance with criteria outlined by the lining manufacturer;

.7 required markings on the portable tank are legible and in accordance with the applicable provisions; and

.8 the framework, supports and arrangements for lifting the portable tank are in a satisfactory condition.

6.7.2.19.9 The inspections and tests in 6.7.2.19.1, 6.7.2.19.3, 6.7.2.19.4, 6.7.2.19.5 and 6.7.2.19.7 should be performed or witnessed by an expert approved by the competent authority or its authorized body. When the pressure test is a part of the inspection and test, the test pressure should be the one indicated on the data plate of the portable tank. While under pressure, the portable tank should be inspected for any leaks in the shell, piping or equipment.

6.7.2.19.10 In all cases when cutting, burning or welding operations on the shell have been effected, that work should be to the approval of the competent authority or its authorized body, taking into account the pressure-vessel code used for the construction of the shell. A pressure test to the original test pressure should be performed after the work is completed.

6.7.2.19.11 When evidence of any unsafe condition is discovered, the portable tank should not be returned to service until it has been corrected and the test is repeated and passed.

6.7.2.20 Marking

6.7.2.20.1 Every portable tank should be fitted with a corrosion-resistant metal plate permanently attached to the portable tank in a conspicuous place readily accessible for inspection. When, for reasons of portable tank arrangements, the plate cannot be permanently attached to the shell, the shell should be marked with at least the information required by the pressure-vessel code. As a minimum, at least the following information should be marked on the plate by stamping or by any other similar method:

Country of manufacture:

U	Approval	Approval	For alternative arrangements
N	country	number	"AA"

Manufacturer's name or mark

Manufacturer's serial number

Authorized body for the design approval

Owner's registration number

Year of manufacture

Pressure-vessel code to which the shell is designed

Test pressure ..... bar/kPa gauge*

MAWP ..... bar/kPa gauge*

External design pressure† ..... bar/kPa gauge*

Design temperature range ..... °C to ..... °C

Water capacity at 20°C ..... litres

Water capacity of each compartment at 20°C ..... litres

Initial pressure test date and witness identification

MAWP for heating/cooling system ..... bar/kPa gauge*

Shell material(s) and material standard reference(s)

Equivalent thickness in reference steel ..... mm

Lining material (when applicable)

Date and type of most recent periodic test(s):

Month ..... Year ..... Test pressure ..... bar/kPa gauge*

Stamp of expert who performed or witnessed the most recent test.

6.7.2.20.2 The following information should be marked either on the portable tank itself or on a metal plate firmly secured to the portable tank:

Name of the operator

Maximum permissible gross mass (MPGM) ..... kg

Unladen (tare) mass ..... kg

6.7.2.20.3 If a portable tank is designed and approved for handling in open seas, the words "OFFSHORE PORTABLE TANK" should be marked on the identification plate.

6.7.3 Provisions for the design, construction, inspection and testing of portable tanks intended for the transport of non-refrigerated liquefied gases of class 2

6.7.3.1 Definitions

For the purposes of this section:

Portable tank means a multimodal tank having a capacity of more than 450 ℓ used for the transport of non-refrigerated liquefied gases of class 2. The portable tank includes a shell fitted with service equipment and structural equipment necessary for the transport of gases. The portable tank should be capable of being filled and discharged without the removal of its structural equipment. It should possess stabilizing members external to the shell, and should be capable of being lifted when full. It should be designed primarily to be loaded onto a transport vehicle or ship and should be equipped with skids, mountings or accessories to facilitate mechanical handling. Road tank-vehicles, rail tank-wagons, non-metallic tanks, intermediate bulk containers (IBCs), gas cylinders and large receptacles are not considered to fall within the definition for portable tanks;

Shell means the part of the portable tank which retains the non-refrigerated liquefied gas intended for transport (tank proper), including openings and their closures, but does not include service equipment or structural equipment;

Service equipment means measuring instruments and filling, discharge, venting, safety and insulating devices;

Structural equipment means reinforcing, fastening, protective and stabilizing members external to the shell;

Maximum allowable working pressure (MAWP) means a pressure that should be not less than the highest of the following pressures measured at the top of the shell while in operating position, but in no case less than 7 bar:

.1 the maximum effective gauge pressure allowed in the shell during filling or discharge; or

* The unit used should be marked

† See 6.7.2.2.10.